

What is claimed is:

1. A sensing apparatus for use in a mass flow rate sensor for measuring a fluid flow rate, comprising:

a main conduit for containing a fluid flow; and,

a capillary tube, disposed about a centerline, for tapping a portion of the fluid flow from the main conduit at a first location, and returning the portion of the fluid flow to the conduit at a second location, the capillary tube including an inner wall, defined by an inside radius measured from the centerline;

wherein the inside radius of the capillary tube varies along the centerline for at least a portion of the capillary tube, thereby forming a turbulated surface on the inner wall.

2. A sensing apparatus according to claim 1, wherein the inside radius varies periodically along the centerline.

3. A sensing apparatus according to claim 1, wherein the inside radius varies sinusoidally along the centerline.

4. A sensing apparatus according to claim 1, wherein the inside radius varies continuously from the first location to the second location.

5. A sensing apparatus according to claim 1, wherein the radius varies along two or more segments of the centerline, each segment separated by regions characterized by substantially constant inside radius.

6. A sensing apparatus according to claim 1, wherein (i) the radius varies along a segment of the centerline, (ii) the radius is substantially constant along the centerline from the first location to the segment of the centerline, and (iii) the radius is substantially constant along

the centerline from the segment to the second location.

7. A sensing apparatus according to claim 1, wherein the turbulated surface on the inner wall of the capillary tube is formed by drilling the capillary tube along the centerline.

8. A sensing apparatus according to claim 1, wherein the turbulated surface on the inner wall of the capillary tube is formed by reaming the capillary tube along the centerline.

9. A sensing apparatus according to claim 1, wherein the turbulated surface on the inner wall of the capillary tube is formed by electro-chemical drilling the capillary tube along the centerline.

10. A sensing apparatus according to claim 1, wherein the turbulated surface on the inner wall of the capillary tube is formed by laser etching the capillary tube.

11. A method of measuring a fluid flow rate that provides a substantially linear output at higher flow rates, comprising:

providing a main conduit for containing a fluid flow; and,

providing a capillary tube, disposed about a centerline, for tapping a portion of the fluid flow from the main conduit at a first location, and returning the portion of the fluid flow to the conduit at a second location, the capillary tube including an inner wall, defined by an inside radius measured from the centerline; and,

varying the inside radius along the centerline for at least a portion of the capillary tube, thereby forming a turbulated surface on the inner wall.

12. A method according to claim 11, further including varying the inside radius periodically along the centerline.

13. A method according to claim 11, further including varying the inside radius sinusoidally along the centerline.
14. A method according to claim 11, further including varying the inside radius continuously from the first location to the second location.
15. A method according to claim 11, further including varying the radius along two or more segments of the centerline, each segment separated by regions characterized by substantially constant inside radius.
16. A method according to claim 11, further including (i) the varying radius along a segment of the centerline, (ii) maintaining the radius substantially constant along the centerline from the first location to the segment of the centerline, and (iii) maintaining the radius substantially constant along the centerline from the segment to the second location.
17. A method according to claim 11, further including forming the turbulated surface on the inner wall of the capillary tube by drilling the capillary tube along the centerline.
18. A method according to claim 11, further including forming the turbulated surface on the inner wall of the capillary tube by reaming the capillary tube along the centerline.
19. A method according to claim 11, further including forming the turbulated surface on the inner wall of the capillary tube by electro-chemical drilling the capillary tube along the centerline.
20. A method according to claim 11, further including forming the turbulated surface on the inner wall of the capillary tube by laser etching the capillary tube.